Original Research Article

EVALUATION OF VARYING FIBRE GLASS WITH PLASTER OF PARIS (POP)

Abstract: Plaster of Paris (POP) was reinforced with Varying particle sizes and percentages of E- type fibre glass. The locally sourced POP processed from gypsum rock was bought from Ibeshe village in Ogun State was used as the matrix while E-type fibre glass was used as reinforcement. The fibre glass was reduced to smaller sizes with the aid of a blender and then sieved through oscillatory sieve shaker to obtain (38, 75, and 150µm) sizes that were used. The composite were developed with varied proportion of the reinforcement (3, 6, 9, 12 and 15 by wt.%) the reinforcement was manually mixed with POP and required quantity of water to form slurry. The obtained slurry was poured into the mold and allowed to cure before removal. The cured samples were sundried for 5 days and latter oven dried. The dried samples were subjected to the following mechanical test (Compressive strength, Hardness and Impact) it was observed that particle size (38µm) and 15 by wt.% gave the optimum result for three mechanical tests carried out. Based on the result obtained, it can be used where unreinforced POP are the major challenges especially where structural properties are required.

Keywords: Pop, Fibre glass, Compressive Strength, Composite, reinforcement.

1. INTRODUCTION

The purpose of any Engineering research is to identify a particular problem or need and possibly provide a solution to the problem. This research has identified the challenges of Plaster of Paris in structural properties and has provided solution to these challenges in the area mentioned. The solution was the reinforced Plaster of Paris composites produced. Composites are designed to combine the best properties of each of its components. The primary objective of engineering composite is to increase strength to weight ratio (Santosh et al, 2014).

Composite material properties are not necessarily isotropic. It can be synthesized according to the type of reinforcing material and the method of fabrication (Kenneth, 2009, Bharat and Jyoti, 2016). The glass fibre may be randomly arranged, flattened into a sheet (called a chopped strand mat) or woven into fabric. Other common names of fibre glass are glass-reinforced plastic GRP (Wang et al; 2004, Mayer, 1993).

Gypsum is naturally occurring as a soft rock in association with limestone, silica, clay and a variety of soluble salt impurities. The change from gypsum to plaster of Paris (POP) during calcination was due to the liberation of water and the hardening of plaster after mixing with water was due to the absorption of water to reform the original compound. The most common types of plaster mainly contain gypsum, lime or cement. (Franz, 2012), though, all work in a similar way. In another word, the plaster is manufactured as dried powder and is mixed with water to form a stiff but workable paste immediately before it is applied to the surface. The reaction with water liberates heat through crystallization and the hydrated plaster then hardens.

Gypsum plaster or (IPOP) is produced by heating gypsum rock to about 300^{o}F (150^{o}C) (Irabor *et al*, 2013).

$$2CaSO_4.2H_2O \xrightarrow[\text{2-3hrs}]{\text{heat } 150^{o}C} CaSO_4.\ 0.5H_2O + 1.5H_2O \text{ .... (1)}$$

Gypsum 2-3hrs POP Water

Reinforced indigenous Plaster of Paris (IPOP) is a composite because the material agrees with the definition of composite materials based on its composition. Composites consist of reinforcement phase and binder phase (Mohammed, 2015). Composites are material systems which are composed of a discrete constituent (the reinforcement) distributed in a continuous phase (the matrix). (Fitzer et al, 2008).

2. MATERIALS AND METHODS:

The main materials used in this research work were Plaster of Paris (POP) was sourced locally from Ibeshe area in Ogun state, Nigeria while the E-type fibre glass was purchased from an open market in Lagos. The materials, gypsum rock, E-type fibre glass and Pulverized POP are shown in fig.1 (a, b and c) below. Other material used are plastic pipes of 25mm diameter was used as mould The strands of fibre glass was reduced with aid of a blender to achieve smaller sizes that can be sieved using the oscillatory sieve shaker. The sizes of 38, 75 and 150 microns were adopted for the research. 50g mixture of POP and fibre glass with water was used to produce different samples with varying reinforcement for the mechanical tests (Impact, Compressive and Hardness) carried out.

Fig.1: Materials used (a: Gypsum rock; b: E-type fibre glass and c: Pulverized POP)

2.1 Material Testing:

2.1.1 <u>Compression Test:</u> Compressive strength or compression strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate. In other words, compressive strength resists compression (being pushed together).

Some materials fracture at their compressive strength limit; others deform irreversibly, so a given amount of deformation may be considered as the limit for compressive load. Compressive strength is a key value for design of structures. Compressive strength is often measured on a universal testing machine (Urbanek and Lee, 2014), (Ritter and Oliva, 1990).

2.1.2 <u>Hardness Test:</u> The hardness of a material is its resistance to penetration under localized pressure or resistance to abrasion. Hardness tests were carried out with the aid of hardness testing machine. In this work, Brinell test method was used. The test was carried at Obafemi Awolowo University Ile-Ife In accordance with ASTM D2240.

2.1.3 <u>Impact Test</u>: An impact test signifies toughness of a material. That is the ability of material to absorb energy during plastic deformation. Static impact tests of unnotched specimens do not always reveal the susceptibility of a metal to brittle fracture. This important factor is determined by impact test. Toughness takes into account both the strength and ductility of the material. (Rajput, 2010). The impact energy test of the composite samples was determined using Charpy impact testing machine with model no 412-07-15269C. The procedure used was in accordance with ASTM D 256. (Adeyanju et al; 2022)

Table 1: Mixed Compositions (compression, hardness, Impact)

Fibre glass (%)	Fibre glass (g)	POP (g)	Total composition (g)
3	1.5	48.5	50.0
6	3.0	47.0	50.0
9	4.5	45.5	50.0
12	6.0	44.0	50.0
15	7.5	42.5	50.0

2.2 Sample Preparation:

2.2.1 Preparation of Compressive and Hardness Samples

The weighed sample of 3% fibre glass i.e 1.5 g was mixed with 48.5 g of POP until a uniform mixture was obtained. The two selected moulds were placed on a flat table. Water of 40 ml was carefully measured and poured into a container, the 50 g mixture of POP and fibre glass were added into the water and stirred until slurry was formed. The slurry was then poured into the moulds and allowed to set (cure). The two samples were removed from the moulds and labeled as 3% samples of 38 microns. Each of the samples was used for compression and hardness tests. The samples were sun dried for 24 hours and later in the oven at 110^{O}C for 5 hours. The same experimental procedure was repeated for samples of 6, 9, 12, and 15 % of 38 microns, 75 microns and 150 microns. In the process, total samples of 30 were produced from the three different particles sizes for each test. Samples without fibre glass were also prepared to serve as control samples.

2.2.2 Preparation of the Impact Samples.

The impact samples were carried out as follows. A basis of 25 g of a mixture of POP, fiber glass and water of 20 ml were used. Moulds of 8mm diameter and 75 mm long were used for each percentage of the samples. The Table 2. Below indicates the proportions for the impact samples. The same experimental procedure was repeated to get the mixture of pop and fibre glass with the aid of electric weigh balance. Water of 20 ml was measured per sample and poured into a container. 25 g mixture which contains 3% fibre glass and 97% POP was carefully poured into it and stirred until slurry was formed and poured into mould. The same procedure was repeated for each sample 6%, 9%, 12% and 15% of 38, 75 and 150 microns respectively. Fifteen samples were produced in the process. The control sample was produced using the same experimental procedure without reinforcement. The samples produced were removed from the moulds and sun dried for 24 hours and later oven dried at 110^{O}C for 5 hours.

Table 2. Mixed Compositions for Impact Testing

Fibre glass %	Fibre glass (g)	POP (g)	Total composition (g)
3	0.75	24.25	25.0
6	1.50	23.50	25.0
9	2.25	22.75	25.0
12	3.0	22.0	25.0

15	3.75	21.25	25.0

3. RESULTS AND DISCUSSIONS

3.1 Compressive Strength Test:

The machine used for the compression test was universal mechanical testing machine commonly called (INSTRON) located at Engineering Materials Development Institute (EMDI) Akure. Based on ASTM C109 standard, the results obtained for varied weight percentages of 3, 6, 9 12 and 15 for particles sizes of 38, 75, and 150 microns are shown on fig.2

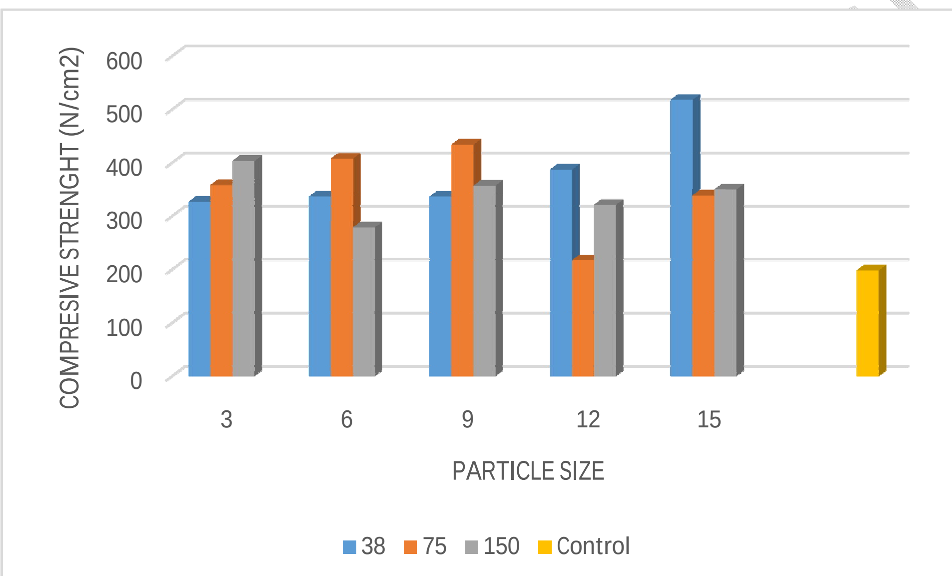

Fig 2: Variation of Compressive Strength against Reinforced Particle sizes

From the fig. 2 above, 15% reinforcement showed a very sharp increase in compressive strength from 38µm particle size with a value of 517.813 N/cm^2 which was the highest value among the varied percentages of compressive strength, this is because the rate of dislocation along the plane in the 38µm particle size was higher than other particle sizes.

3.2 Hardness Test

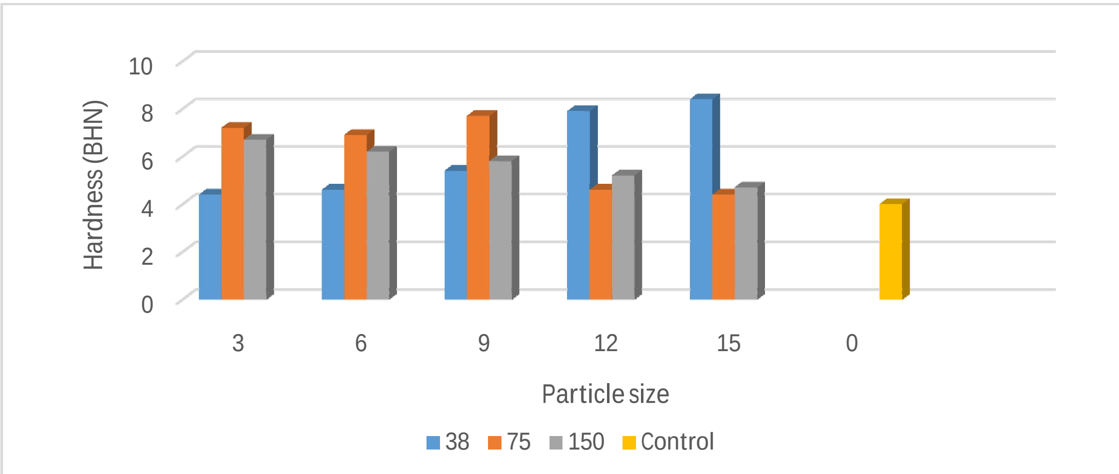

Fig 3 Variation of Hardness test (BHN) against Reinforced Particle Size

From fig.3 above, the corresponded hardness result shows that unreinforced sample had the lowest value of 4.0 BHN. 15% sample of 38µm has the highest value of 8.4BHN which implies that it was the hardest in term of hardness.

3.3 Impact Test

The Impact test measures the materials ability to withstand sudden (impact) load without fracturing. This test was also carried out on all the samples based on ASTM D256 standard. The test was done at Obafemi Awolowo University Ile- Ife. Charpy impact technic was used. The results obtain were tabulated in fig. 4 below.

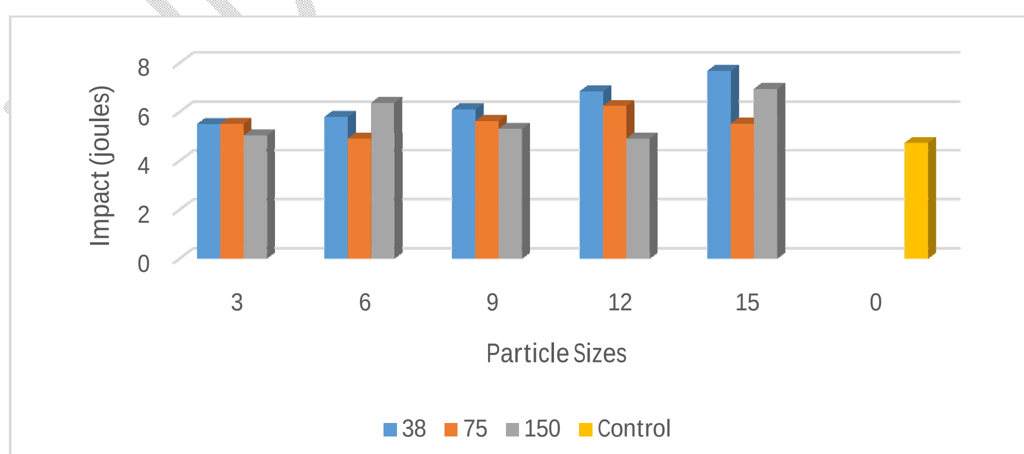

Fig. 4 Variation of Impact (Joules) against Reinforced Particle sizes

From fig.4 showed above, unreinforced sample has the lowest impact value of 4.72J, 15% of 38 microns has the highest impact value of 7.67J while two samples (12% of 150 microns and 6% of 75 microns) had the same value of 4.90J to be the least in impact value according to the test in the table.

CONCLUSION

The test carried out namely, compressive strength, hardness and impact it is concluded that:

I. Reinforced samples exhibited better properties than unreinforced in all the tests carried out.

II. Among the three particle sizes considered (38, 75, and 150) microns, samples that contained 15% of 38µm size of fibre glass gave the optimum values for all the tests carried out in the research.

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